Basic Toxicology*

*Extracted from the Testimony of Jack W. Snyder, M.D., J.D., Ph.D., Annapolis Center for Science-Based Public Policy, appearing on behalf of Western Environmental Trade Association, Helena, Montana, submitted to the Montana Board of Environmental Review on July 5, 2006.

Basic Toxicology[i]

The toxicity of any element or compound primarily depends upon four factors.

1. **Speciation** or specific formula of the material. Not all toxicants are created equal. Some materials are more toxic than others, even if they incorporate a common chemical component such as mercury, lead, or cyanide. For example, HCN, also known as hydrocyanic acid or cyanide gas, is a deadly poison which can kill if ingested in small amounts. However, when the CN (cyanide) molecule is complexed with cobalt and some other elements in a certain formula, you have Vitamin B-12, a compound essential to good health.

   In the case of mercury, the form of concern is methylmercury (MeHg), which is ingested by humans almost exclusively by eating fish. In contrast, the form of mercury emitted by coal-fired power plants is primarily elemental mercury with some in an oxidized state as well.

2. **Dosage.** There is an old saying that "the dose makes the poison," and it is literally true. This is readily seen with pharmaceuticals when a substance is a highly efficacious curative at one dosage but capable of causing death at another, usually a higher dosage.

   The same principle applies to mercury compounds in the environment. People breathe in elemental mercury every day; it's omnipresent in the atmosphere but

is present in such low concentration that it has no adverse effect. Also, human beings have not been shown to be capable of converting elemental mercury into appreciable amounts of methylmercury within their bodies.

3. **Exposure Pathway.** The exposure pathway is the route by which a toxicant enters the body. For agents found in the natural environment, the most common exposure pathways are inhalation, ingestion through food and/or water, and absorption through the skin.

Mercury is not appreciably absorbed through the skin, nor is it found in the atmosphere in sufficient quantities to make inhalation of the substance problematic, even downwind of coal-fired electric generating stations.[ii]

The only exposure pathway of consequence for mercury in human beings and terrestrial wildlife is through the ingestion of foods, almost exclusively fish and shellfish, which accumulate methylmercury in their flesh.

4. **Duration of Exposure.** Some toxicants act quickly and, if consumed in sufficient quantities, can rapidly cause injury or death. Other toxicants act over longer periods, and only cause damage over time by bio-accumulating to toxic levels in an organism. In the case of methylmercury found in the environment, it takes repeated exposures over time, if ever, before this agent can cause harm. To mitigate the potential for adverse health effects related to chronic toxicity,

governmental regulatory agencies have established exposure standards which are sufficiently conservative to prevent toxicity even after a lifetime of exposure. That standard typically is known as a reference dose. The EPA has established the most conservative standard at .1 micrograms (0.1 ppb) of methylmercury per kilogram of body weight per day for a lifetime. The Agency for Toxic Substances and Disease Registry uses .3 micrograms. Additionally, the U.S. Food and Drug Administration prohibits the sale of fish and shellfish containing over 1 microgram of mercury.

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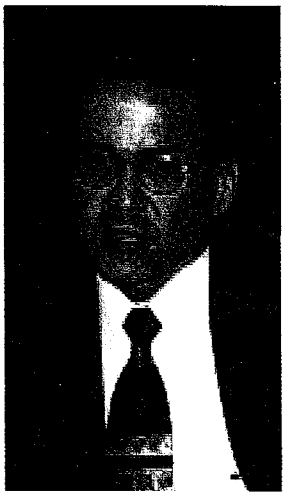
[i] This section provides a general overview to the basic elements of toxicology. The reader is encouraged to consult the sources which follow for additional detail: Goldfrank L. *Toxicologic Emergencies.* New York. McGraw-Hill Medical Publishing, 2002; Dart R. et al. *Medical Toxicology.* Philadelphia. Lippincott, Williams & Wilkins. 2004; Ford M. *Clinical Toxicology.* Philadelphia. Saunders. 2001.

[ii] Mercury, in sufficient concentration, can be toxic when inhaled. These conditions rarely exist outside of industrial settings. Global background concentrations of mercury in the atmosphere are about 1.2-1.4 nanograms of mercury per cubic meter of air. The Occupational Safety and Health Administration (OSHA) sets a limit of no more than 0.1 milligrams of mercury per cubic meter of air and a level of .05 milligrams per cubic meter for air in the workplace during a 40-hour work week. So levels of mercury in the air we breathe range from a thousand to a million times lower than the limit set by OSHA to prevent injury.

Jack W. Snyder, M.D., J.D., Ph.D.



Jack W. Snyder resides in Potomac, Maryland and currently serves as the Associate Director of Specialized Information Services, National Library of Medicine at the National Institutes of Health in Bethesda, Maryland.

Snyder is a physician, a lawyer, a toxicologist, and a member of the Board of Directors of the Annapolis Center for Public Policy, a research and education enterprise committed to fostering the use of credible, verifiable science in public policy decision making.

Background

Snyder is a physician-attorney with training and experience in pharmacology, toxicology, pathology, public health, medical management, and medical informatics. Prior to assuming his current role, he held various positions in academia and industry and has been a frequent lecturer, advisor and consultant to corporate, academic, legal and governmental organizations in matters involving public health, legal medicine and forensic science, laboratory medicine, toxic torts, workers' compensation, hazardous waste, occupational disease, disaster planning and adverse drug reactions.

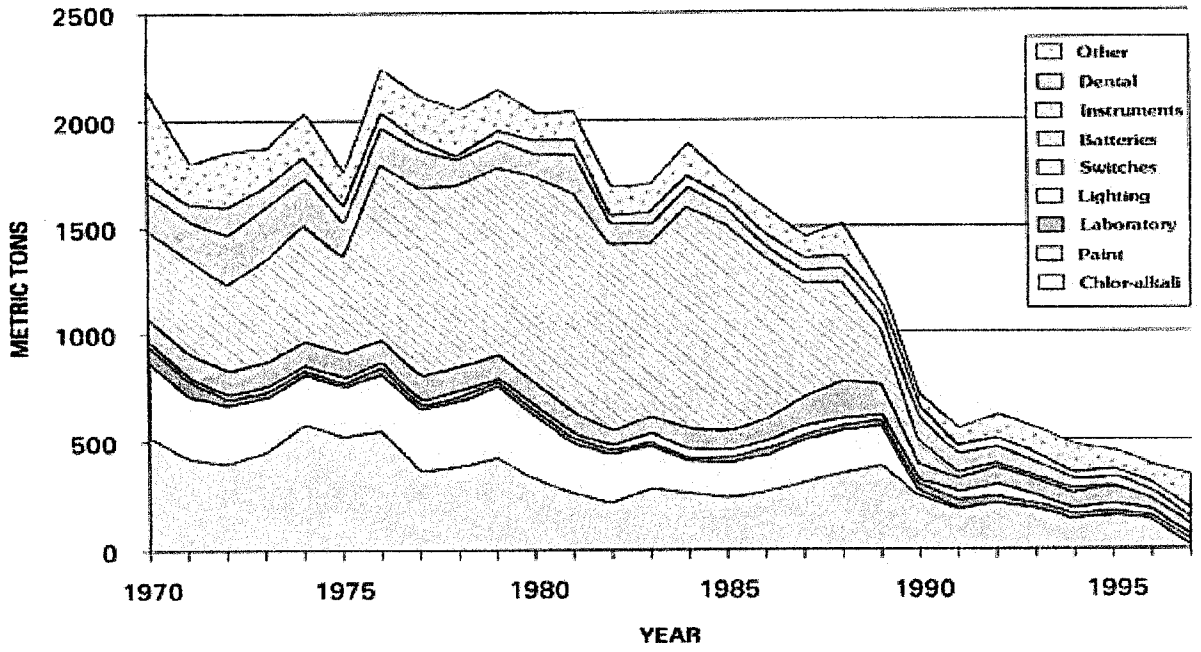
Credentials

- •B.S. Chemistry and M.D. Northwestern University
- •Master of Forensic Science George Washington University
- •Ph.D. Pharmacology & Toxicology Medical College of Virginia
- •Past President, American College of Legal Medicine
- •Registered Patent Attorney
- •Master of Public Health John Hopkins University
- •J.D. Georgetown University
- •Board of Directors of the Annapolis Center
- •Secretary, American Board of Legal Medicine

Certification as a diplomat of the American Boards of Preventive (Occupational) Medicine, Toxicology, Medical Toxicology, Toxicological Chemistry, Clinical Chemistry, Legal Medicine, Quality Assurance & Utilization Review, and Anatomic, Clinical and Chemical Pathology

He is widely published in medical, scientific and legal journals.

Industrial Use of Mercury in the United States



Source: The Annapolis Center for Science-Based Public Policy, *Mercury in the Environment: The Problems, the Risks, and the Consequences,* 2003.

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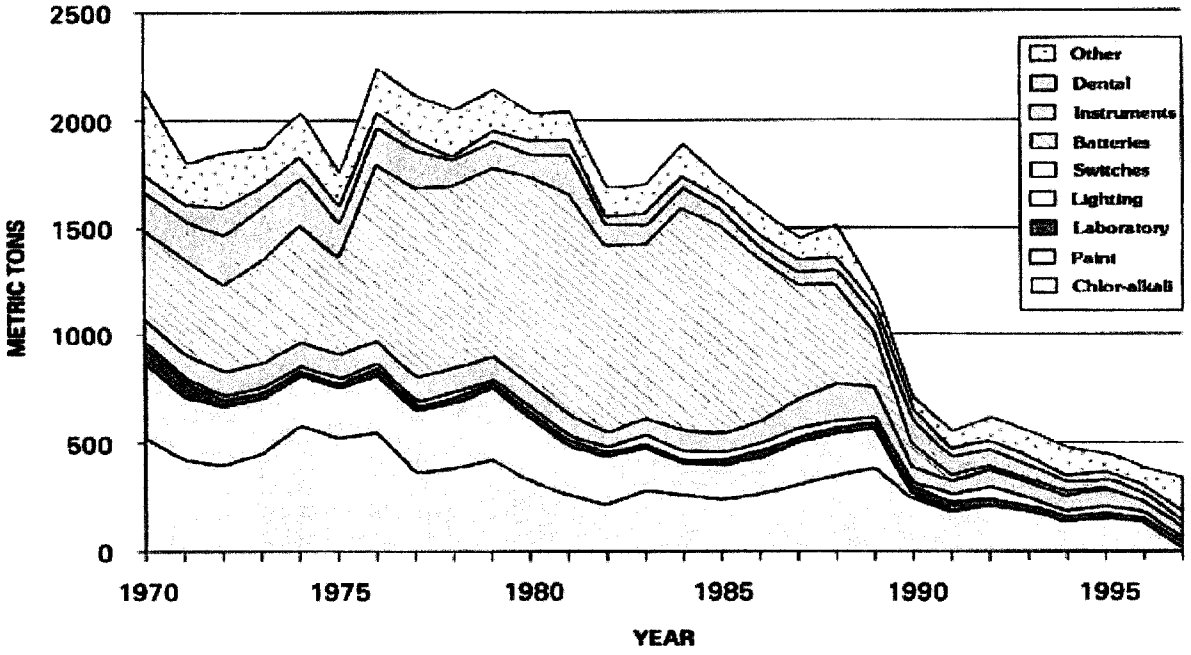

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